Chemical Engineering and Technology 2017 vol.40 N5, pages 829-837

# Detection of Microscale Mass-Transport Regimes in Supercritical Fluid Extraction

Salamatin A.
*Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia*

## Abstract

© 2017 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim The problem of detecting supercritical fluid extraction regimes on the particle-scale level is discussed by using a generalized multiparameter model, which includes the shrinking-core (SC) and broken-and-intact-cells (BIC) approaches as its limiting cases. The model accounts for two internal mass-transfer resistances attributed to cell membranes and transport channels. A wide spectrum of particle-scale extraction regimes, described by the model, agree with available up-to-date relatively short laboratory experiments. Simplified concepts (like SC or BIC) could only be used for available experimental data correlation, and do not allow a reliable extension to long process times. The experimental methodology was suggested to detect limiting internal mass-transfer mechanisms.

http://dx.doi.org/10.1002/ceat.201600599

## Keywords

Broken-and-intact-cells model, Cell membrane permeability, Extraction curves, Mass transfer, Shrinking core model

## References

[1] Green Chemistry: Theory and Practice (Eds: P. T. Anastas, J. C. Warner), Oxford University Press, Oxford 1998.
[2] G. Brunner, Annu. Rev. Chem. Biomol. Eng. 2010, 1, 321–342. DOI: 10.1146/annurev-chembioeng-0730-9-101311
[3] E. Schutz, Chem. Eng. Technol. 2007, 30 (6), 685–688. DOI: 10.1002/ceat.200600297
[4] J. M. del Valle, J. Supercrit. Fluids 2015, 96, 180–199. DOI: 10.1016/j.supflu.2014.10.001
[5] M. Bravi, R. Bubbico, F. Manna, N. Verdone, Chem. Eng. Sci. 2002, 57 (14), 2753–2764. DOI: 10.1016/S0009-2509(02)00145-8
[6] L. Fiori, Chem. Eng. Process 2010, 49 (8), 866–872. DOI: 10.1016/j.cep.2010.06.001
[7] A. A. Salamatin, A. G. Egorov, J. Supercrit. Fluids 2015, 105, 35–43. DOI: 10.1016/j.supflu.2015.01.013
[8] A. G. Egorov, A. A. Salamatin, Russ. Math. 2015, 59 (2), 48–56. DOI: 10.3103/S1066369X15020073
[9] L. Fiori, D. Calcagno, P. Costa, J. Supercrit. Fluids 2007, 41 (1), 31–42. DOI: 10.1016/j.supflu.2006.09.005
[10] X. Han, L. Cheng, R. Zhang, J. Bi, J. Food Eng. 2009, 92, 370–376. DOI: 10.1016/j.jfoodeng.2008.12.002
[11] M. Goto, B. C. Roy, T. Hirose, J. Supercrit. Fluids 1996, 9 (2), 128–133. DOI: 10.1016/S0896-8446(96)90009-1
[12] A. G. Egorov, A. A. Salamatin, Chem. Eng. Technol. 2015, 38 (7), 1203–1211. DOI: 10.1002/ceat.201400627
[13] H. Sovova, Chem. Eng. Sci. 1994, 49 (3), 409–414. DOI: 10.1016/0009-2509(94)87012-8
[14] H. Sovova, J. Supercrit. Fluids 2012, 66, 73–79. DOI: 10.1016/j.supflu.2011.11.004
[15] L. Fiori, D. Basso, P. Costa, J. Supercrit. Fluids 2009, 48 (2), 131–138. DOI: 10.1016/j.supflu.2008.09.019

[16] C. Marrone, M. Poletto, E. Reverchon, A. Stassi, Chem. Eng. Sci. 1998, 53 (21), 3711–3718. DOI: 10.1016/S0009-2509(98)00150-X

[17] E. L. G. Oliveira, A. J. D. Silvestre, C. M. Silva, Chem. Eng. Res. Des. 2011, 89 (7), 1104–1117. DOI: 10.1016/j.cherd.2010.10.025

[18] Z. Zekovic, S. Filip, S. Vidovic, S. Jokic, S. Svilovic, Chem. Eng. Technol. 2014, 37 (12), 2123–2128. DOI: 10.1002/ceat.201400322

[19] A. Rai, K. D. Punase, B. Mohanty, R. Bhargava, Int. J. Heat Mass Transfer 2014, 72, 274–287. DOI: 10.1016/j.ijheatmasstransfer.2014.01.011

[20] V. Abrahamsson, N. Andersson, B. Nilsson, C. Turner, J. Supercrit. Fluids 2016, 111, 14–27. DOI: 10.1016/j.supflu.2016.01.006

[21] M. Poletto, E. Reverchon, Ind. Eng. Chem. Res. 1996, 35 (10), 3680–3686. DOI: 10.1021/ie9600093

[22] A. K. K. Lee, N. R. Bulley, M. Fattori, A. Meisen, J. Am. Oil Chem. Soc. 1986, 63 (7), 921–925. DOI: 10.1007/BF02540928

[23] J. M. del Valle, P. Napolitano, N. Fuentes, Ind. Eng. Chem. Res. 2000, 39, 4720–4728. DOI: 10.1021/ie000034f

[24] E. F. Moura, M. C. Ventrella, S. Y. Motoike, Sci. Agric. 2010, 67 (4), 399–407. DOI: 10.1590/S0103-90162010000400004

[25] D. M. Joel, H. Bar, A. M. Mayer, D. Plakhine, H. Ziadne, J. H. Westwood, G. E. Welbaum, Ann. Bot. 2012, 109 (1), 181–195. DOI: 10.1093/aob/mcr261

[26] A. Femenia, M. Garcia-Marin, S. Simal, C. Rossello, M. Blasco, J. Agric. Food Chem. 2001, 49 (12), 5828–5834. DOI: 10.1021/jf010532e

[27] A. Lehner, F. Corbineau, C. Bailly, Plant Cell Physiol. 2006, 47 (7), 818–828. DOI: 10.1093/pcp/pcj053

[28] B. Honarvar, S. A. Sajadian, M. Khorram, A. Samimi, Braz. J. Chem. Eng. 2013, 30 (1), 159–166. DOI: 10.1590/S0104-66322013000100018

[29] Y. Liu, Y. Zhao, J. Zhao, Y. Song, Magn. Reson. Imaging 2010, 29 (8), 1110–1118. DOI: 10.1016/j.mri.2011.05.009

[30] A. G. Egorov, A. A. Salamatin, R. N. Maksudov, Theor. Found. Chem. Eng. 2014, 48 (1), 39–47. DOI: 10.1134/S0040579514010011

[31] A. A. Salamatin, IOP Conf. Ser.: Mater. Sci. Eng. 2016, 158, 012081. DOI: 10.1088/1757-899X/158/1/012081

[32] U. Salgin, H. Korkmaz, J. Supercrit. Fluids 2011, 58 (2), 239–248. DOI: 10.1016/j.supflu.2011.06.002

[33] S. G. Ozkal, M. E. Yener, L. Bayindirli, J. Supercrit. Fluids 2005, 35 (2), 119–127. DOI: 10.1016/j.supflu.2004.12.011

[34] L. Fiori, J. Supercrit. Fluids 2009, 50 (3), 218–224. DOI: 10.1016/j.supflu.2009.06.011

[35] L. Fiori, J. Supercrit. Fluids 2007, 43 (1), 43–54. DOI: 10.1016/j.supflu.2007.04.009